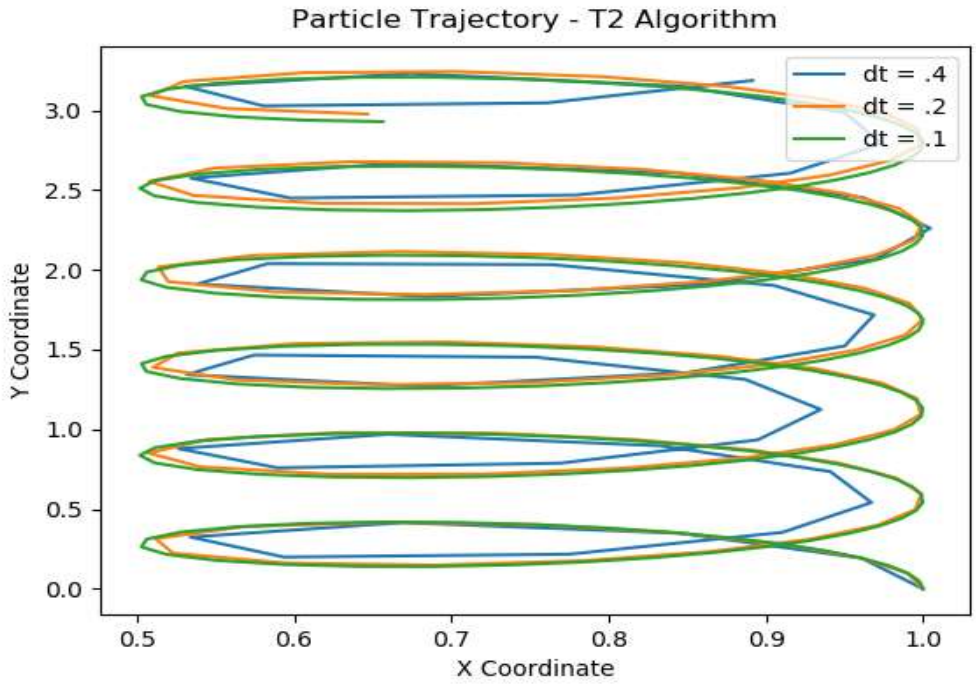
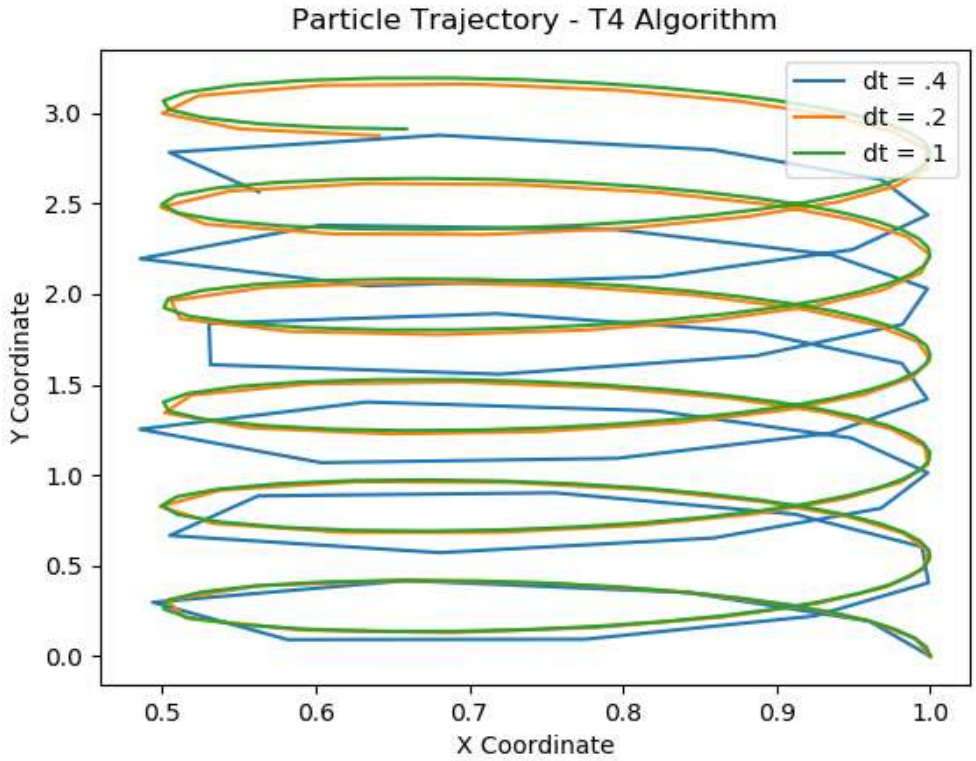
Problem 1:

1a) In a magnetic B field of the form $\vec{B}=(0,0,1/x^2)$, a projectile is launched from $\vec{r}=(1,0,0)$ with velocity $\vec{v}=(0,0.5,0)$. The following is a plot of this particle's trajectory using a second order algorithm of time step of 0.04, 0.02, and 0.01.

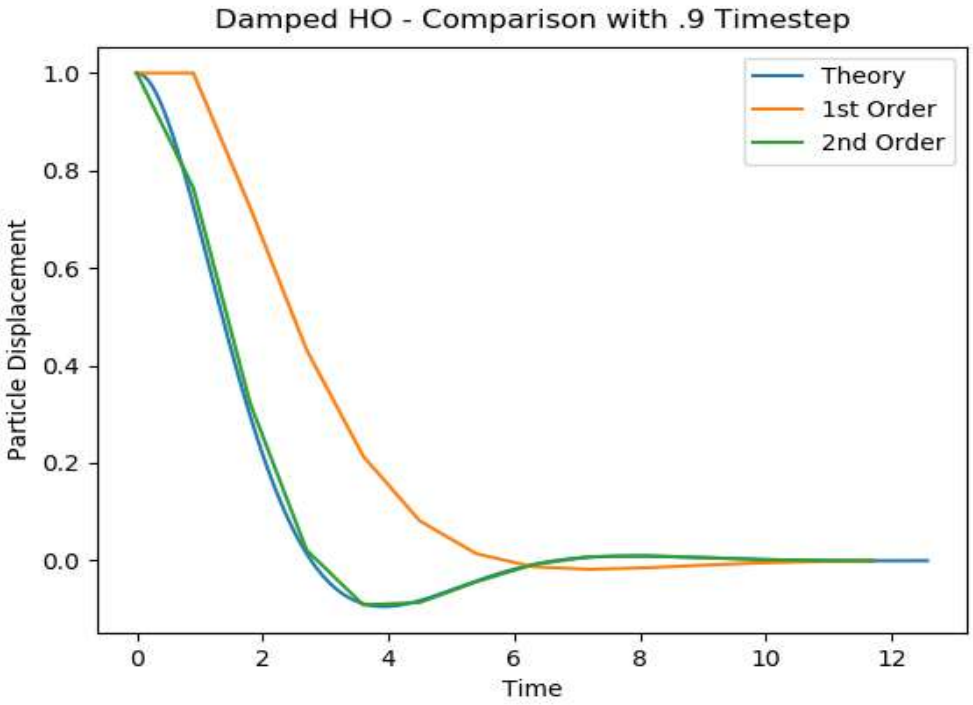


1b) The same trajectories, but using a T4, Forest Ruth algorithm.



Problem 2:

2a) For the given parameters, we compare the trajectories of a 1st and 2nd order algorithm with the theoretical calculation of a damped harmonic oscillator using a time-step of 0.9 (a large time-step so we may actually see the difference between theory and the 2nd order):



How would you measure the error in this case when we do not have a Hamiltonian?

Since we have already calculated the theoretical value as a function of time, we would simply invoke the following formula:

$$E(t) = x(t)_{algorithm} / x(t)_{theory} - 1$$

2b) Solving again using a 4^{th} order algorithm: